UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, D.C. 20460

ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM
VERIFICATION STATEMENT

TECHNOLOGY TYPE:	**PASSIVE SOIL GAS SAMPLER**
APPLICATION:	**SUBSURFACE SOIL GAS SAMPLING**
TECHNOLOGY NAME:	**EMFLUX® SOIL GAS INVESTIGATION SYSTEM**
COMPANY:	**QUADREL SERVICES, INC.**
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ETV PROGRAM DESCRIPTION

The U.S. Environmental Protection Agency (EPA) created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative technologies through performance verification and information dissemination. The goal of the ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. The ETV Program is intended to assist and inform those involved in the design, distribution, permitting, and purchase of environmental technologies. This document summarizes the results of a demonstration of the Quadrel Services, Inc., EMFLUX® Soil Gas Investigation System.

PROGRAM OPERATION

Under the ETV Program, and with the full participation of the technology developer, the EPA evaluates the performance of innovative technologies by developing demonstration plans, conducting field tests, collecting and analyzing demonstration data, and preparing reports. The technologies are evaluated under rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the demonstration results are defensible. EPA's National Exposure Research Laboratory, which demonstrates field characterization and monitoring technologies, selected Tetra Tech EM Inc. as the verification organization to assist in field testing various soil and soil gas sampling technologies. This demonstration was conducted under EPA's Superfund Innovative Technology Evaluation Program.

DEMONSTRATION DESCRIPTION

In May and June 1997, the EPA conducted a field test of the EMFLUX® system along with one other soil gas and four soil sampling technologies. This verification statement focuses on the EMFLUX® system; similar statements have been prepared for each of the other technologies. The performance of the EMFLUX® system was compared to the reference sampling method, active soil gas sampling, which provides a snapshot of the soil gas environment at the time the sample is collected. The comparison addressed three parameters: (1) volatile organic compound (VOC) detection and quantitation, (2) sample retrieval time, and (3) cost. Data quality indicators for precision, accuracy, representativeness, completeness, and comparability were also assessed against project-specific QA objectives to ensure the usefulness of the data for the purpose of this evaluation.

The EMFLUX® system was demonstrated at two sites: the Small Business Administration (SBA) site in Albert City, Iowa, and the Chemical Sales Company (CSC) site in Denver, Colorado. These sites were chosen because each site exhibited a wide range of VOC concentrations and a distinct soil type. VOCs detected at the sites include: vinyl

chloride; cis-1,2-dichloroethene (cis-1,2-DCE); 1,1,1-trichloroethane (1,1,1-TCA); trichloroethene (TCE); and tetrachloroethene (PCE). The SBA site is composed primarily of clay soil, and the CSC site is composed primarily of medium- to fine-grained sandy soil. A complete description of the demonstration, including a data summary and discussion of results, is available in the report titled Environmental Technology Verification Report: Passive Soil Gas Sampler, Quadrel Services, Inc., EMFLUX®, EPA/600/R-98/096).

TECHNOLOGY DESCRIPTION

The EMFLUX® system is a passive soil gas sampling technology designed for use in shallow deployment to identify and quantify a broad range of VOCs and semivolatile organic compounds (SVOC), including halogenated compounds, petroleum hydrocarbons, polynuclear aromatic hydrocarbons, and other compounds present at depths to more than 200 feet. For this ETV demonstration, the EMFLUX® system consisted of the EMFLUX® sample cartridge, sample insertion tools, and developer-provided sample analysis. The EMFLUX® cartridge consists of 100 milligrams of sorbent sealed in a fine-mesh screen, which is placed in a glass vial; the vial and cartridge make up the EMFLUX® field collector. This assembly is inserted into the soil, but only the cartridge is thermally desorbed and analyzed in the laboratory. The EMFLUX® field collector is installed by creating a three to four-inch deep pilot hole using a manual hammer and a stake, and inserting the sampler manually. The sampler is then covered to reduce the potential for sorption of airborne contaminants. The cartridge is retrieved by hand and, for this demonstration, was analyzed by the developer. The EMFLUX® system also includes computer modeling by Quadrel using a proprietary model to predict periods of maximum soil gas emission for geographic locations and optimize sampling efficiency. However, the performance of the model was not evaluated during the demonstration.

VERIFICATION OF PERFORMANCE

The demonstration data indicate the following performance characteristics for the EMFLUX® system:

VOC Detection and Quantitation: Soil gas samples collected using the EMFLUX® system and the reference soil gas sampling method at nine grids at both the sites were analyzed for six target VOCs. Analysis of EMFLUX® samples yielded results in total nanograms per sample, which Quadrel converted to mass per unit volume of air (nanograms per liter [ng/L]). The reference method also produced results in mass per unit volume of air (ng/L). A comparison of the mean VOC concentrations calculated for each sampling method at each grid indicates that the EMFLUX® system identified the presence of all of the VOC compounds detected by the reference soil gas sampling method in 24 of 25 cases. In addition, in 7 of 31 cases, the EMFLUX® system also reported VOCs that the reference method did not detect but were identified as present during previous soil and groundwater investigations at the demonstration sites. This performance characteristic suggests that the EMFLUX® system can detect the presence of lower concentrations of VOCs in soil gas than the reference soil gas sampling method. In addition, the sample locations where the EMFLUX® system reported high VOC concentrations generally corresponded to the sample locations where the reference method also reported high VOC concentrations. However, the values in the two data sets do not appear to exhibit any direct or consistent proportional relationship, and the mean concentrations of VOCs calculated using the reference method data were typically one to four orders of magnitude higher than those calculated using the EMFLUX® system for samples from the same grid. Because the EMFLUX® system relies on diffusion of soil gas from subsurface sources such as contaminated soil or groundwater, the performance range for the EMFLUX® system may be controlled by factors such as depth to the contaminant source, contaminant concentrations and diffusion rates, soil type and organic content, the detection limits of the methods used to analyze the samples, and possibly other factors. However, during the demonstration, the system was evaluated at locations with relatively shallow subsurface contamination, and was only evaluated with regard to its ability to detect certain targeted VOCs. For these reasons, the performance range of the EMFLUX® system was not fully established by the demonstration data. It should be noted that the EMFLUX® system and reference method are field screening techniques that provide only an estimate of the actual concentration of contaminants in soil gas. Because the EMFLUX® system and reference method use different techniques to collect soil gas samples, it is not expected that the two methods will provide the same response and that the data will be directly comparable. Because the mean VOC concentrations for the data sets differ by several orders of magnitude in most instances, a statistical analysis of the data was not performed and interpretation of the chemical concentration data for this demonstration is limited to qualitative observations.

Sample Retrieval Time: Installation of the EMFLUX® system averaged 3.0 minutes per sample at the SBA site and 4.0 minutes per sample at the CSC site. For the demonstration, the samplers were left in place for approximately 4

days at each site. Collection of the samplers required an average of 2.3 minutes per sample at the SBA site and 3.2 minutes at the CSC site. Overall, installation and collection of 35 samples at the SBA site required 187 minutes, an average of 5.3 minutes per sample and installation and collection of 28 samples at the CSC site required 201 minutes, an average of 7.2 minutes per sample. The analysis and reporting by the technology developer required an additional 12 days for the SBA site data and 16 days for the CSC site data from the time samples were collected until the laboratory report was delivered. The reference soil gas method required 458 minutes to collect 35 samples at the SBA site, an average of 13.1 minutes per sample, and 183 minutes to collect 28 samples at the CSC, an average of 6.5 minutes per sample. One day was required per site to analyze the samples and report the results. Based on the demonstration results, the average sample retrieval times for the EMFLUX® system were quicker than those of the reference soil gas sampling method in the clay soils at the SBA site and slower than those of the reference sampling method in the sandy soils at the CSC site. During sample collection using the reference soil gas sampler, the clay soil at the SBA site caused the system to hold its vacuum at several sampling locations; therefore, soil gas was not completely drawn into the system for sampling. In these cases, the rod was withdrawn in additional 6-inch increments until the vacuum was broken and the system's pressure reached equilibrium with atmospheric pressure. The vacuum problem was not encountered in the sandy soil at the CSC site. At both sites, one person collected soil gas samples with the EMFLUX® system, and a three-person sampling crew collected and analyzed soil samples using the reference sampling method.

Cost: Based on the demonstration results, the EMFLUX® system costs were $85 to $195 per sample plus equipment costs of $25 to $90 per day and mobilization/demobilization costs of $200 to $600 per day. Operating costs for the EMFLUX® system ranged from $810 to $1,590 at the clay soil site and $860 and $1,640 at the sandy soil site. For this demonstration, the active soil gas sampling method was procured at a lump sum of $4,700 for each site. The oversight costs for the active soil gas sampling method ranged from $680 to $1,260 at the clay soil site and $480 to $910 at the sandy soil site. A site-specific cost and performance analysis is recommended when selecting a subsurface soil gas sampling method.

A qualitative performance assessment of the EMFLUX® system indicated that (1) the samplers are reliable in that 100 percent of the required samples were collected with no sample losses; (2) the samplers are easy to use and require minimal training (a 16-minute training video is available from the developer); (3) logistical requirements for the EMFLUX® system differ from those of the reference sampling method because the EMFLUX® field collectors are installed using a hammer-driven, 6-inch steel rod, left in place for several days, retrieved by hand, and sent to the developer for analysis; and (4) sample handling in the field was easier than the reference method because the only requirements are that the recovered cartridges be properly packed, and shipped to the developer for analysis.

The demonstration results indicate that the EMFLUX® system can provide useful, cost-effective data for environmental problem-solving. The EMFLUX® system successfully collected soil gas samples in clay and sandy soils. The sampler provided positive identification of target VOCs and may be able to detect lower concentrations of VOCs in the soil gas than the reference method. The results of the demonstration did not indicate consistent proportional comparability between the EMFLUX® data and the reference method's data. As with any technology selected, the user must determine what is appropriate for the application and the project data quality objectives.

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NOTICE: EPA verifications are based on an evaluation of technology performance under specific, predetermined criteria and appropriate quality assurance procedures. EPA makes no expressed or implied warranties as to the performance of the technology and does not certify that a technology will always operate as verified. The end user is solely responsible for complying with any and all applicable federal, state, and local requirements.